Center Innovation Fund: LaRC CIF

Multi-Parameter Measurement in Unseeded Flows using Femtosecond Lasers (Tier 1)

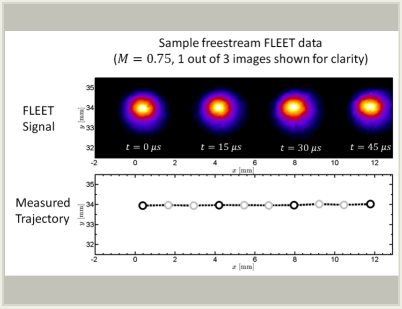
Completed Technology Project (2013 - 2014)

Project Introduction

Measurements in NASA's wind tunnels generally consist of force and moment and on-body measurements like surface pressure, surface deflection or heat transfer to the surface. Detailed off-body measurements are needed to understand complex wind tunnel flows and to provide data to validate high-fidelity computational models. Most existing techniques capable of measuring detailed off-body flows, for example, particle image velocimetry, require particle or gas seeding which is not possible in many of NASA's tunnels. In this project, two techniques utilizing new femtosecond laser technology will be investigated. Both techniques show promise of measuring multiple parameters quantitatively in unseeded wind tunnel flows. The femtosecond laser electronic excitation and tagging (FLEET) technique can measure velocity and potentially pressure and temperature simultaneously. The femtosecond coherent anti-Stokes Raman spectroscopy (FS-CARS) technique can measure pressure, temperature and species concentrations. The two techniques have relative advantages and limitations that will be explored. The objective of this research project is to leverage recent advancements in laser technology and recent discoveries in academia to discover and apply new ways of measuring aerospace flows. In particular, methods of measuring the gas velocity, pressure, temperature and concentration will be developed. The two different measurement techniques share a common femtosecond laser technology and can be used separately or together to measure multiple gas properties simultaneously in wind tunnel flows and possibly in flight. In this project, we are extending the ability of FLEET to measure multiple parameters such as pressure and temperature simultaneous with velocity. These additional parameters will be obtained by observing and interpreting the amplitude and spectrum of the FLEET signal. The main novelty of the proposed work is that FLEET should allow velocity to be measured in several facilities where velocity cannot be curren

Anticipated Benefits

Can provide unique off-body data in wind tunnel tests to help understand the flowfield and to provide quantitative data to validated computations of the flow. Also can help screen different vehicle or flow control technologies to evaluate their effectiveness.



Sample freestream FLEET data

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Innovation Fund: LaRC CIF

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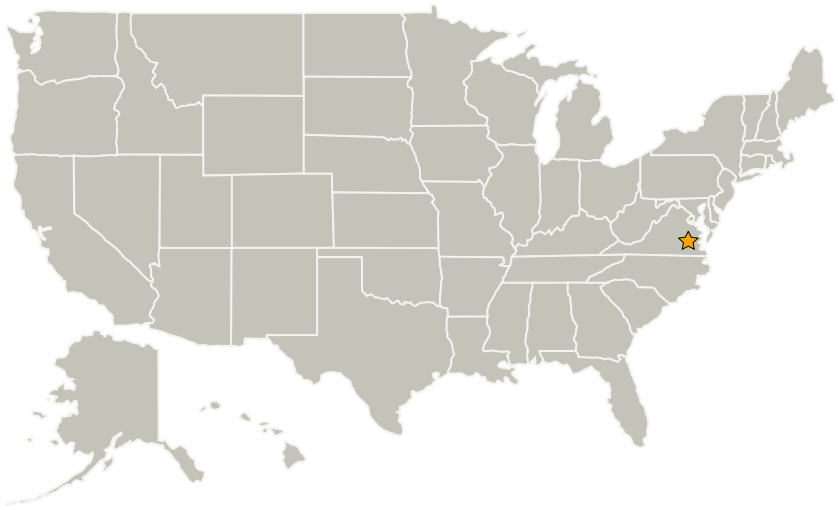
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia

Co-Funding Partners	Type	Location
George Washington University	Academia	Washington, District of Columbia
National Institute of Aerospace	Academia	Hampton, Virginia
Princeton University	Academia	Princeton, New Jersey
Sandia National Laboratories(SNL)	R&D Center	Albuquerque, New Mexico
Spectral Energies, LLC	Industry Small Disadvantaged Business (SDB)	Dayton, Ohio

Project Management

Program Director:
Michael R Lapointe

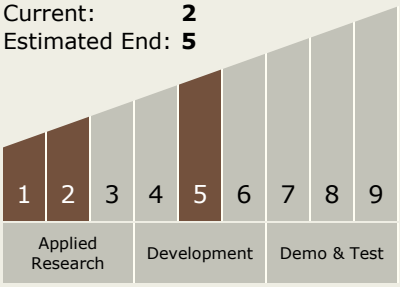
Program Manager:
Julie A Williams-byrd

Project Manager:
Paul M Danehy

Principal Investigator:
Paul M Danehy

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **5**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.8 Ground and Flight Test Technologies

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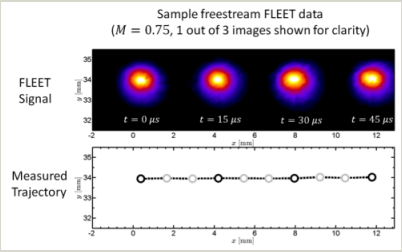
Images



Sample freestream FLEET data
Sample freestream FLEET data
(https://techport.nasa.gov/image/18371)

Stories

Application of FLEET Velocimetry in the NASA Langley 0.3-meter Transonic Cryogenic Tunnel
(https://techport.nasa.gov/file/27015)

Precision of FLEET velocimetry using High-Speed CMOS Camera Systems
(https://techport.nasa.gov/file/27016)

Pressure Monitoring using Hybrid fs/ps Rotational CARS
(https://techport.nasa.gov/file/27014)